Probability Based Corrosion Control

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We Put Science To Work

E. Hoffman, P. Zapp

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Outline

- Current chemistry control program
- Initiative for broader chemistry control
  - Lower nitrite requirement
- Statistical test matrix
- Electrochemical/Visual results
- Benefits

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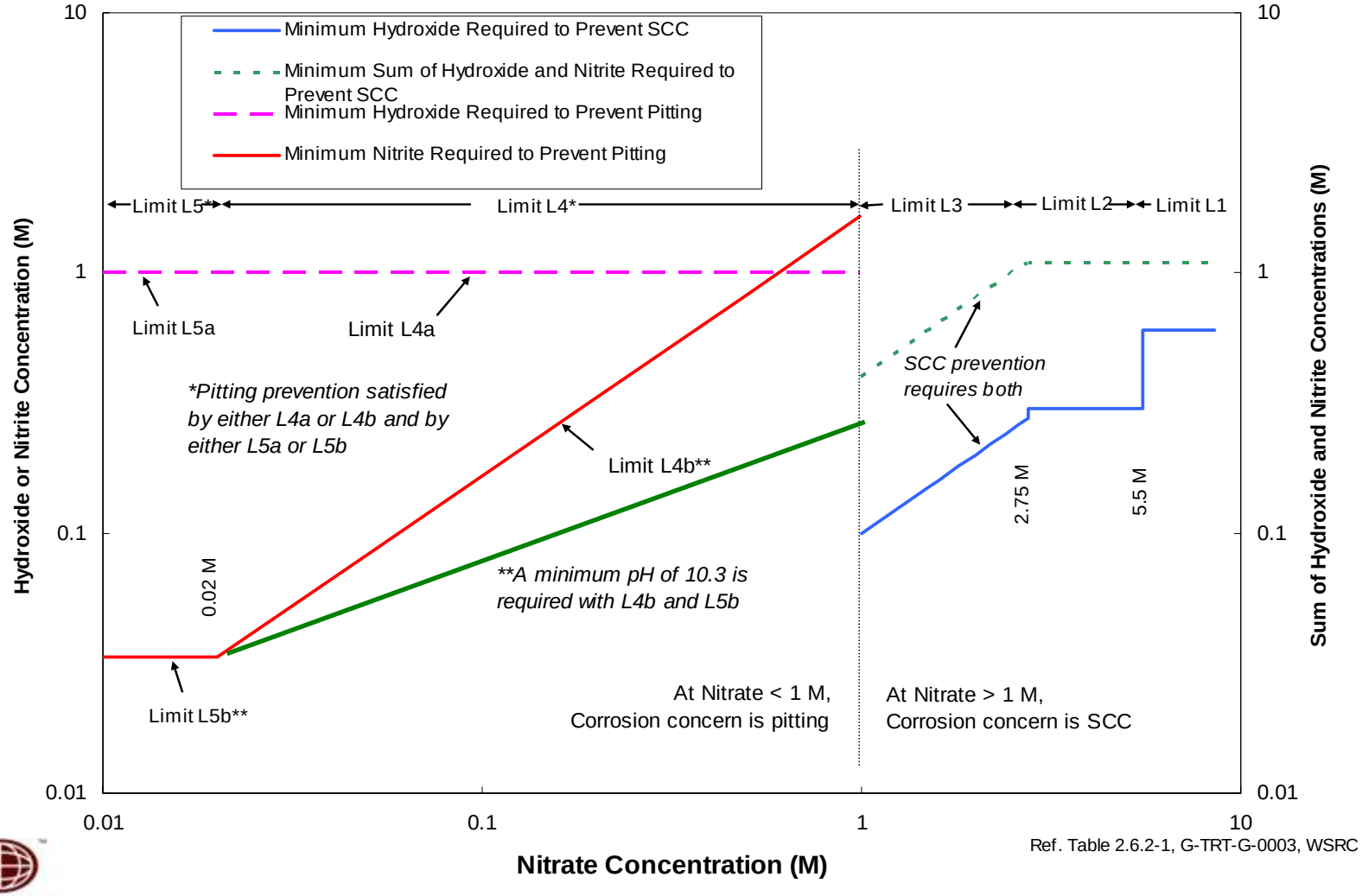
Current Chemistry Controls



Ref. Table 2.6.2-1, G-TRT-G-0003, WSRC

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Broader Chemistry Control Initiative

- Chemistry control program intended to prevent pitting for $[NO_3^-] < 1$ M
- Requirements
  - $[OH^-]_{min} = 1$ M
  - $[NO_2^-]$ minimum with pH > 10.3
- Option 1: Lower hydroxide requirements
- **Option 2: Lower nitrite requirements**
  - **Probabilistic basis for pitting control with nitrite**

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Development of Statistical Basis

- Investigate various solution chemistries to determine the minimum molar nitrite concentration to eliminate conservatism in the current limit, while confidently inhibit pitting
- Design space of $0.02\ M \leq [NO_3^-] \leq 1\ M$
  - Limit to 40 °C
- Logistic regression

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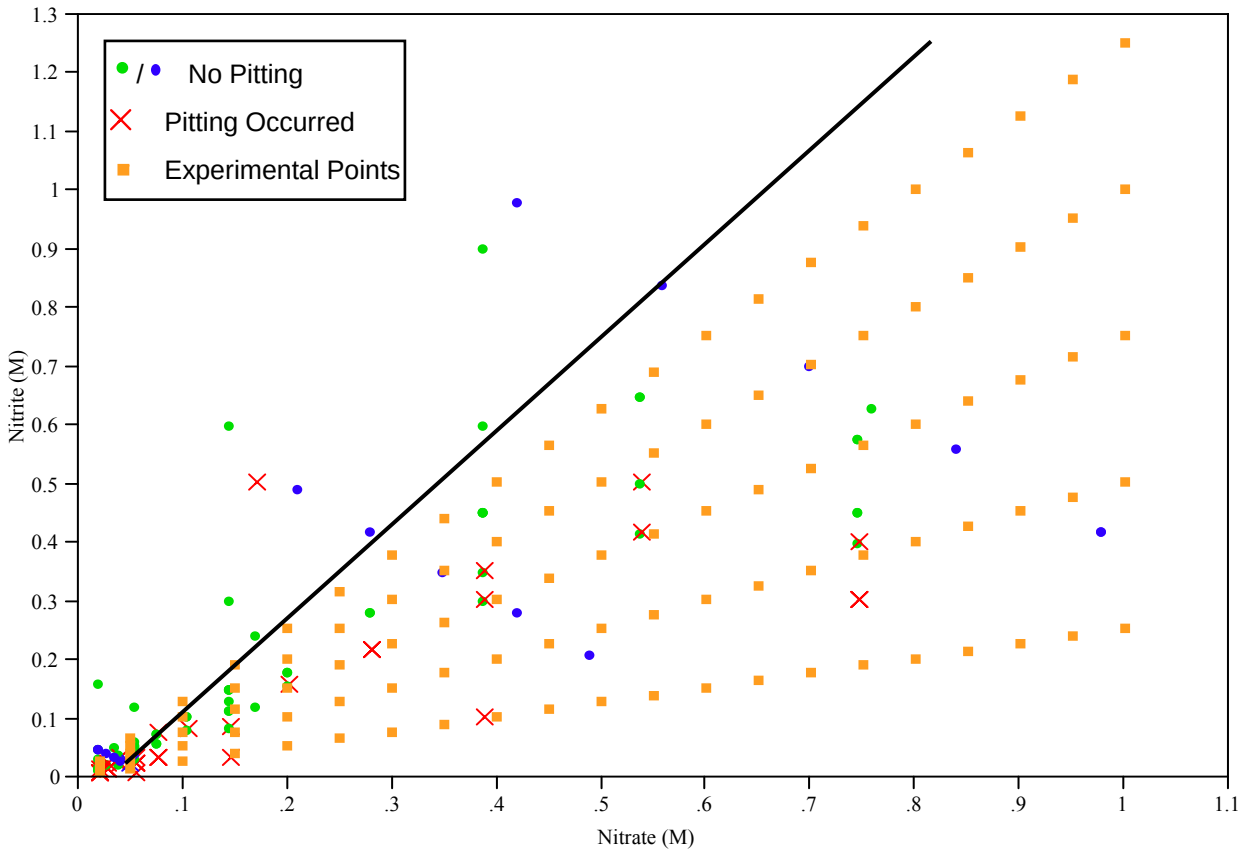
Complete Test Matrix



- 105 test points along set R-values
- Multiple tests at each design point
- ***Electrochemical*** and coupon testing
- Addition of chlorides/sulfates per maximum current requirements
- pH controlled with buffered solution

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Cyclic Polarization Scan

- Repassivation/Protection Potential
  - Cessation of pitting

- Corrosion /Open Circuit Potential
- Transpassive Potential
- Pitting Potential
  - Breakdown potential near the open circuit potential

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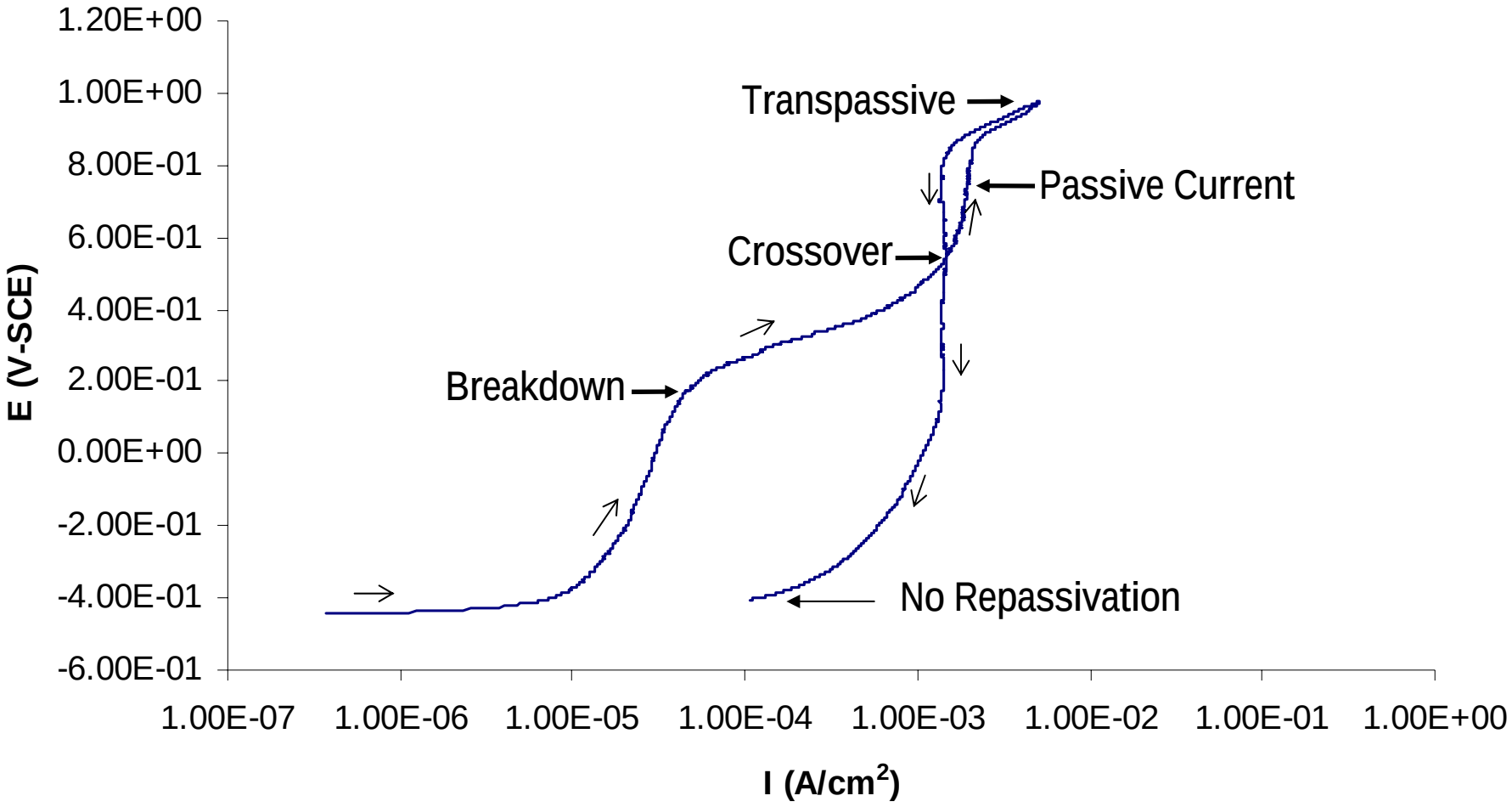
Electrochemical Scan Result



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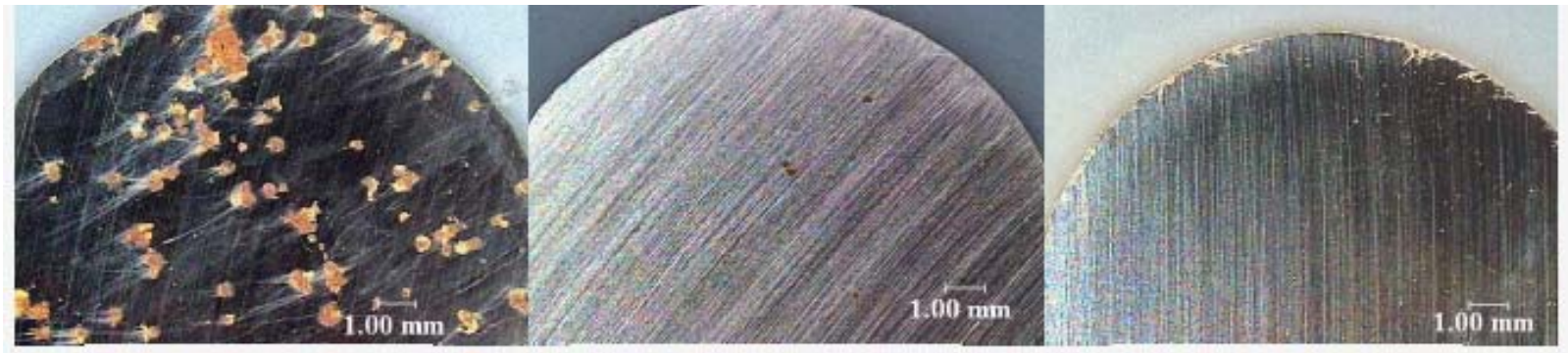
Results

- Cyclic potentiodynamic polarization scans
  - Corrosion potential
  - Pitting potential – premature breakdown or transpassive
  - Repassivation potential if present
- Visual observation of electrochemical coupons
  - Categorized as None/Moderate/Significant
  - Monitored electrochemical potentials where corrosion occurred

Heavy Pitting *Moderate Pitting* *No Pitting*



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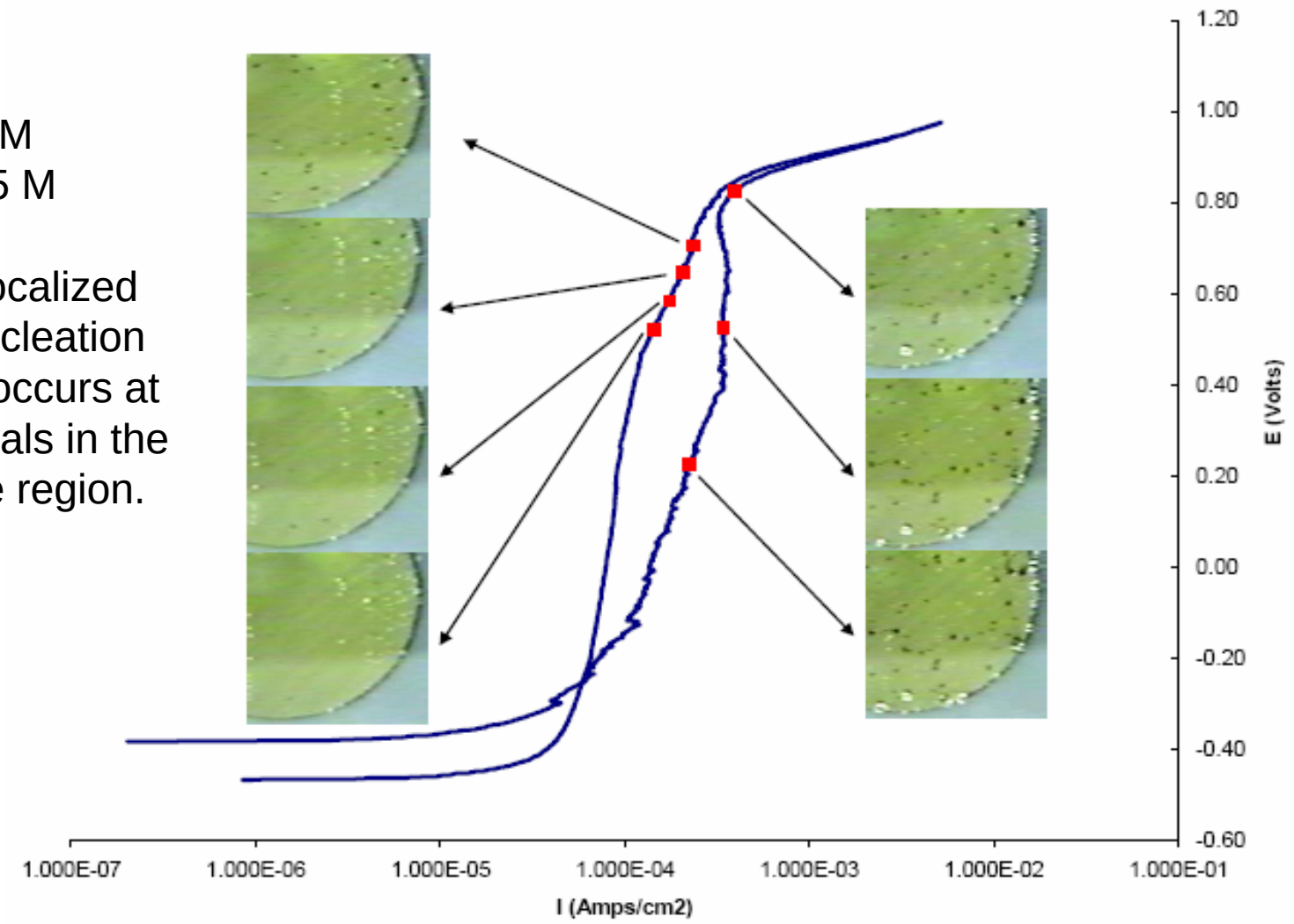
Corrosion Evolution during Electrochemical Run

Solution
$[NO_3^-]$ = 0.6 M
$[NO_2^-]$ = 0.15 M

Majority of localized corrosion nucleation and growth occurs at large potentials in the transpassive region.



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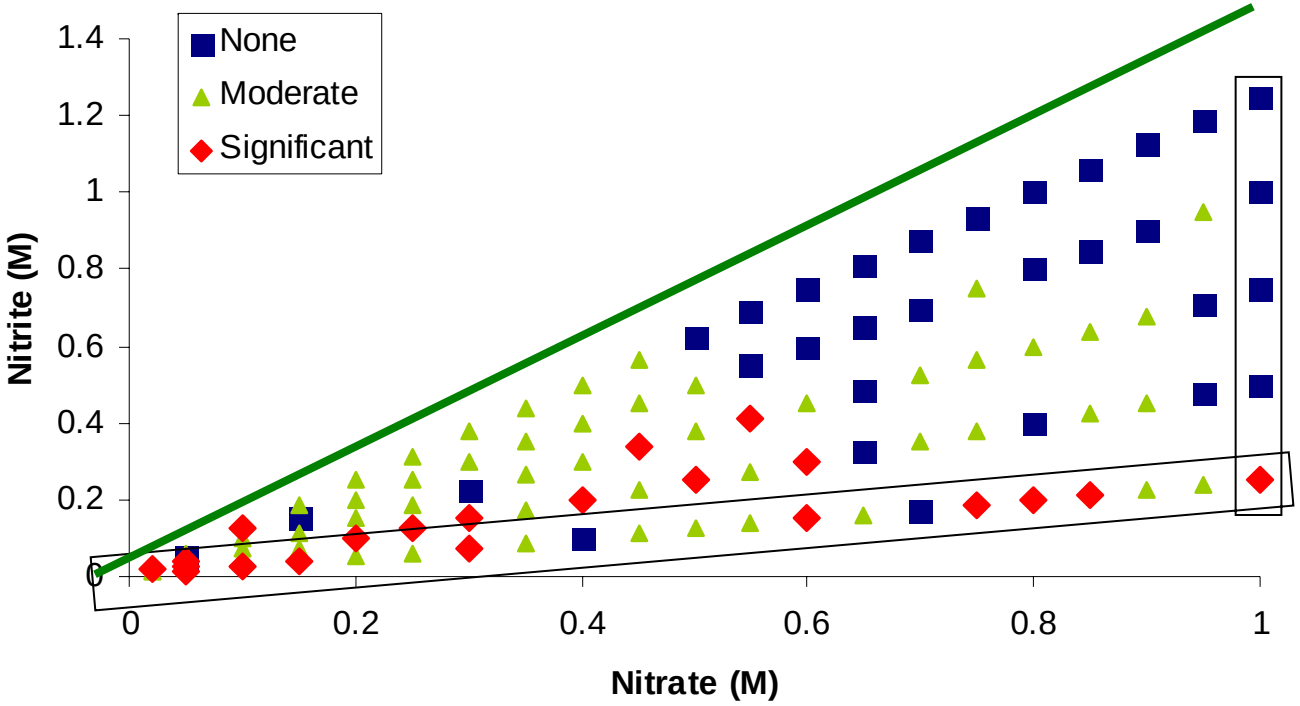
Summary of Visual Results

Heavy Pitting *Moderate Pitting* *No Pitting*

Visual observations reveal that inhibitor additions lower than current requirements are sufficient.



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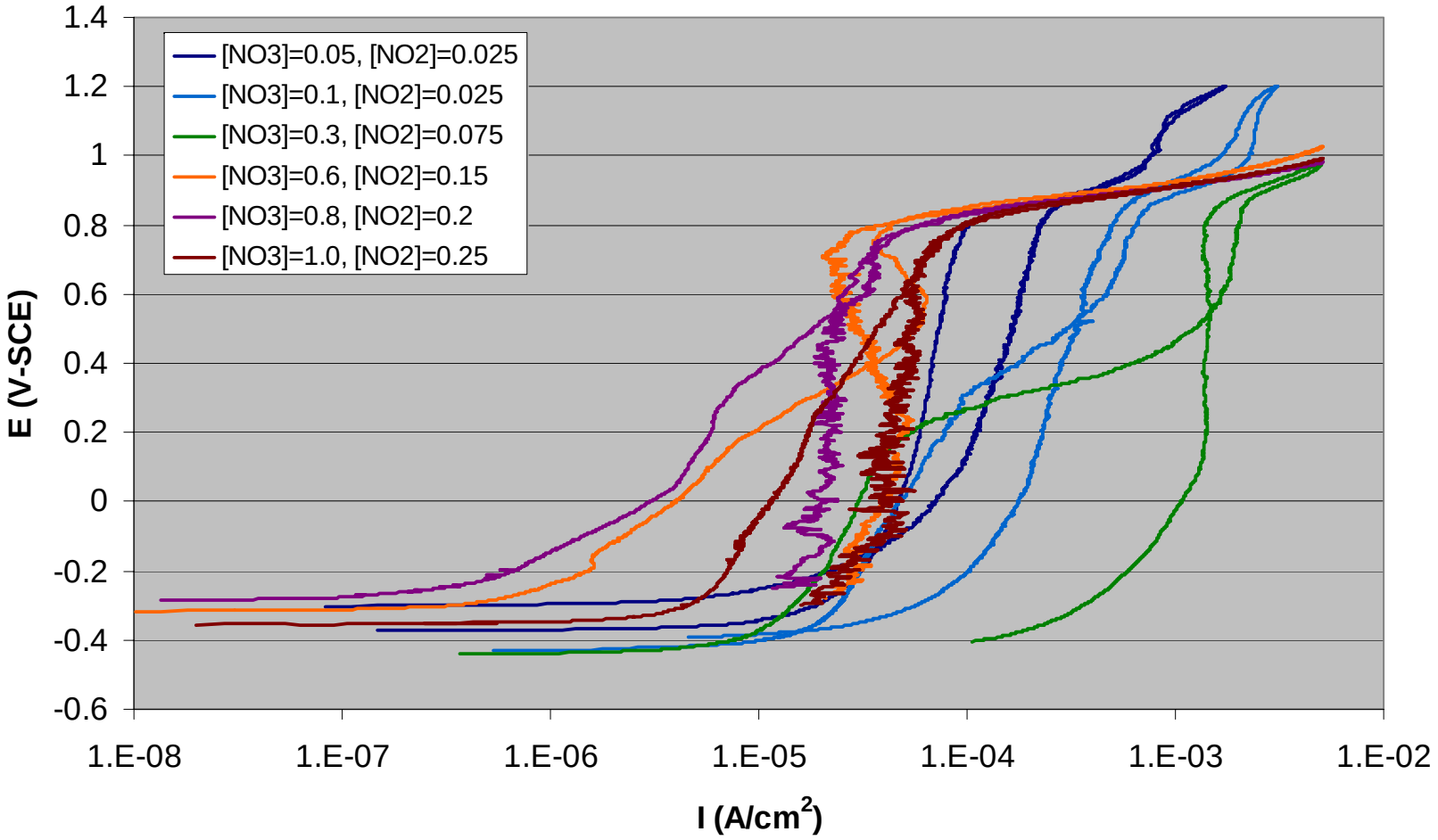
Lowest Level of Nitrite Inhibitor Addition



Results suggest that absolute value of inhibitor is sufficient, rather than R-value.

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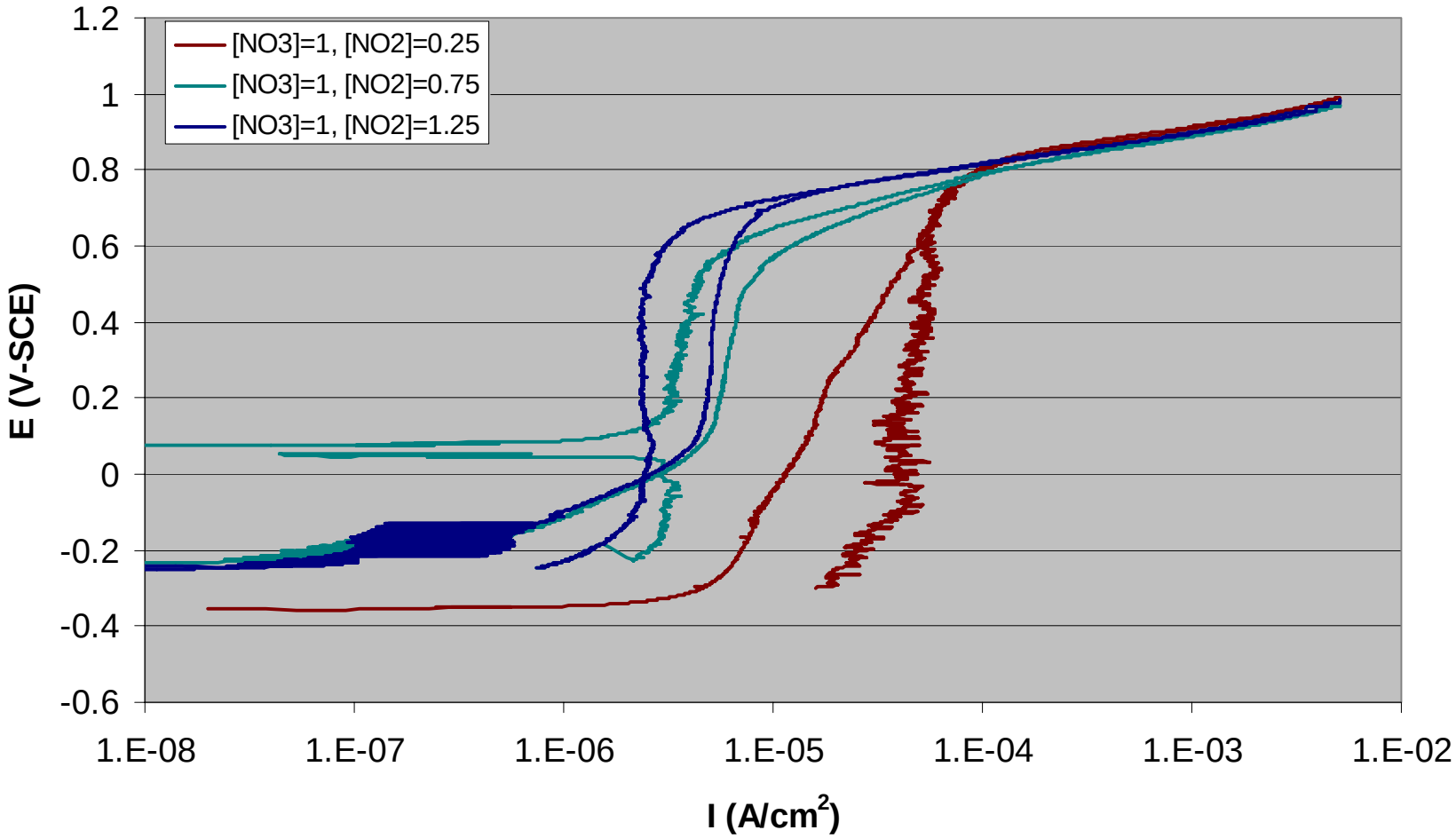
Scans Performed with 1 M $NaNO_3$



Potential limit exists beyond which nitrite addition as a corrosion inhibitor does not add value.

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Conclusion/Path Forward

- Critical nitrite concentration exists to sufficiently inhibit against localized corrosion mechanisms due to nitrates, chlorides, and sulfates.
  - Based upon electrochemical cyclic polarization
  - Based upon visual observations
- Coupon testing is currently underway.
- Completed electrochemical samples are being statistically analyzed.
  - Electrochemical curve
  - Optical/visual results

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Benefits

- Reduces unnecessary conservatism in support of tank closure goals.
- Quantifies risk of pitting associated with particular chemistries.
- Maximum savings of tank space and cost of maintaining unnecessarily conservative chemistry control measures.
- Allows for tank specific risk acceptance.

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